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From flint razors to lasers: a timeline of hair removal methods

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Summary

Today, most do not go a day without practicing or hearing about new hair removal methods. However, little is discussed about the history of hair removal and the development of most hair removal methods since the period of cavemen. Avoiding decapitation and fitting in with society are two of many reasons for the development of this now normative practice. Knowledge of the hair growth cycle is vital in understanding the efficacy of various hair removal methods as well as the difference between epilation and depilation. While laser hair removal (LHR) is one of the most common cosmetic procedures practiced in the world, according to the FDA, the only current permanent form of hair removal is electrolysis. These two methods as well as various other ones are discussed in this article. Further developments are being made every day to better treat the removal of blonde and white hair as well as to diminish the pain of hair removal. With these developments, dermatologists will better understand the advancement of hair removal methods and the reasons why patients may seek treatment.

Keywords: epilation, hair reduction, hair removal, hair removal laser, hair growth

Introduction

Hair is one of the defining characteristics of mammals that is found almost entirely over the body. Hair as an entity, is divided into two parts: 1) the hair follicle (found below the skin), which is responsible for the production and growth of the 2) hair shaft (what is seen above the skin).[1] Its distribution is highly attributed to sex hormones and in both genders, it is only absent from the sides and surfaces of the hands, sides and plantar surfaces of the feet, lips, and urogenital openings.[2] While there are numerous functions of the hair follicle as well, for the purpose of this study, we shall only discuss the functions of the hair shaft. Some of the functions of the hair shaft include a means for social communication, protection against trauma and electromagnetic radiation, a sensory antennae to feel the environment, insulation against heat loss and gain, a mechanism of cleansing the skin's surface and outwards transport of signals (i.e., sebum, pheromones).[3] Depending on the location, shafts can vary in color, type, and size, which can be shaped by the individual to deliver a message to society. Many individuals dye their hair, others curl or straighten it, and more commonly almost all practice some form of hair removal.

Hair removal has been a fascination to humans since prehistoric times, which according to archaeologists, actually began with cavemen. The popularity of hair removal has and still is mostly influenced by society and what is deemed the social norm at that time. In a recent study, it was found that over 99% of participants practiced some form of hair removal, with shaving and plucking being the most common removal methods.[9] In this article, we aim to educate the reader about the history of hair removal by discussing the different hair removal methods, what was used, and the various reasons why hair removal was performed

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during different times dating back to 30 000 B.C. We provide a brief overview of hair growth (including anatomy and the hair growth cycle), as well as a brief overview of the main reasons and methods for hair removal, leading to a thorough review of what was used and why.

This topic, although important, is one in which minimal research has been performed. Our focus in this study is to provide the history of hair removal and how the different methods have advanced through time. With this timeline, dermatologists and other hair removal specialists will have a comprehensive understanding of how hair removal has developed and the reasons why patients may seek hair removal treatments.

Hair growth

Basic hair follicle anatomy

To better understand the hair growth cycle, one must first have a basic understanding of the anatomy of the hair follicle. The hair follicle is the structure from which hair grows. It is divided into the infundibulum (hair follicle opening to insertion of the sebaceous gland), isthmus (insertion of the sebaceous gland to the insertion of the arrector pili muscle), and inferior segments (insertion of the muscle to the base of the hair follicle).[1] The dermal papilla is the command center at the base of the follicle that dictates hair shaft size, length, and possibly cycling.[4] It is the part of the hair follicle that receives the blood and nutrients necessary for hair growth. The hair shaft is the part of the hair follicle that is visible to the human eye and differs in shape, type, and color. Moreover, the hair follicle can be divided into two parts: a permanent portion (above the muscle insertion) and a nonpermanent cycling portion below.[3]

Hair growth cycle

Hair growth is not a steady linear process, but rather a cyclic one consisting of periods of growth and no growth. The hair follicle is the only mammalian organ that undergoes cyclic transformations from stages of rapid growth (anagen) to bulbar degradation by apoptosis (catagen) and a transitional resting period (telogen).[4] It is estimated that 85–90% of hairs are found in anagen, in which the mitotic activity in the hair bulb and papilla resume forming the new hair shaft, pushing out the old (nonpermanent) hair with the others found in telogen.[5,6] The time spent in each phase, however, is not uniform; rather it is body site-dependent. For the scalp, the anagen phase can range from 2 to 6 years, whereas for the thighs, the range may last from 1 to 2 months; a telogen phase for the mustache can range from 1 to 1.5 months, and for the legs, from 3 to 6 months.[7] This is imperative for removal treatment purposes, as hairs respond better to treatment while in the anagen phase. Alteration of the matrix cell activity during anagen causes either early cessation of anagen leading to telogen, transition into a dystrophic stage of anagen, or degeneration of the matrix, all of which increase the amount of time between hair removal and regrowth.[5] For optimal treatment results, it would be beneficial for dermatologists to have a method in which they would be able to easily identify the current phase of the cycle the hair is in.

History of hair removal

Reasons throughout history for Hair Removal

According to archaeologists, hair removal has been around since prehistoric times. Although the specific reasons for hair removal continually change, the want to get rid of unnecessary hair still remains. The most common reasons other than surgery, childbirth, or the prevention of lice, have been found to be due to social norms, cultural and religious traditions, esthetics, and personal preference.[8]

Customs, whether social, religious, or cultural, have always been a major influence for hair removal. As customary practice, brides removed their body hair except from their eyebrows and head the night before their wedding in the Middle East, whereas Buddhist priests shave their heads for religious reasons.[8] However, other reasons for hair removal were for more practical purposes. The ancient Egyptians shaved their heads to keep cool in the heat and also to prevent infestation with lice.[8] In addition, men would shave their faces and heads during wars to prevent the enemy from being able to grab them and to prevent decapitation.[13] Alexander the Great and his soldiers also removed their beards for the same reason.[13] Due to these purposes, hair removal lost its popularity until the beginning of the Crusades in 1096 CE.[8]

One of the biggest and most prevalent influences for hair removal to this day is what is popular in a particular society during that time, such as social norms. Hair removal has also been found to be an indication of class. Throughout the Middle Ages, high foreheads and paleness defined beauty so women plucked their eyebrows and hair on foreheads and hairlines to achieve this look.[8] Currently, the trend in contemporary Western cultures is to begin the hair removal process as soon as women start producing more visible body hair (puberty).[9] The removal of hair from the legs became a cultural norm for women in Western Society as clothes became more revealing due to society encouraging the unveiling of the female body.[8] This was strongly influenced by the publishing in 1914 of the first hair removal advertisement in the women's magazine, *Harper's Bazaar*, encouraging women to shave.[12] When the first Gillette razor for women was introduced in 1915, the advertisements for hair removal for women took off.[12]

Moreover, society's influence regarding the ideal gender highly impacts the practice of hair removal in addition to the individual's personal preference. In a survey by Toerien *et al.*,[9] they noted that women who view hair as masculine will remove some of their hair and highlighted an association between hair or lack thereof and ideal gender. In another study performed, it was found that greater cleanliness, sex appeal, and the creation of a muscular, toned silhouette were some of the reasons for male depilation today.[11]

Methods of hair removal

There are two main categories of hair removal methods known as depilation and epilation. Depilation is the sole removal of the hair shaft, not affecting the hair bulb with results lasting up to 2 weeks.[5,7] Some of the most common used depilatories are shaving and chemical depilatories, such as calcium hydroxide with sodium hydroxide. Epilation is the removal of the entire hair shaft and bulb with results lasting 6–8 weeks.[5,7] Some commonly used epilators are waxing, sugaring, tweezing, threading, laser hair removal, and electrolysis. Usually epilation does not change the rate of hair growth unless the hair is removed during the anagen state.[7] How these methods developed and what has been used to achieve them is discussed (Table 1), while a timeline of important events throughout the history of hair removal is provided (Fig 1).

Methods of depilation

Shaving

Shaving is one of the most well-known cost efficient methods of depilation (removal of the hair above the skin). It is the most popular form of hair removal for men's facial hair and women's underarm and leg hair.[8,16] The two main techniques of shaving are wet shaving with a safety razor and dry shaving with an electric shaver. However, safety razors in general are more preferred over electric shavers by both men and women since a closer shave can be achieved.[17] This is due to the razor blade being able to cut hairs closer to the surface of the skin leaving a more uniform stubble, thus producing a smoother shave.[16]

Contrary to popular belief, shaving does not change the thickness or growth rate of hair. Shaving does cause a blunt tip *vs.* the natural soft textured tip of uncut hair, thus making the hair seem thicker.[7] Due to this effect, shaving is not a preferred form of facial hair removal for women.[5,7,17] Unfortunately, this easy method of removing unwanted hair is only temporary, as the hair cycle is unaltered leading to the need to shave almost daily.[16,18]

Chemical depilatories

Chemical depilatories are another simple and common method of hair removal at the level of the surface of the skin. The mechanism of action involves disrupting the disulfide bonds of the hair's protein structure and dissolving the hair shaft; hence, it can easily be separated from the hair follicle.[19] Their popularity is due to the simple and painless process of removal with a slower regrowth time and less bristle tip than with shaving; results usually last up to 2 weeks.[7]

Although this method is easy and readily available, skin irritation due to the chemicals are common. Mercaptens, 2–10% thioglycolates, mixed with 2–6% of either NaOH or CaOH are widely used to disrupt the disulfide bonds especially those involving cystine.[20] These chemicals must be left on the skin for about 3–15 minutes giving enough time to for the hair to break at or slightly below the surface of the skin and can then be wiped off.[15]

Methods of epilation

Plucking/tweezing

Plucking is a simple and easy technique for removal of the entire hair shaft and hair bulb with tweezers. This method proves very effective in removing hair from small areas, such as the eyebrows, upper lip, as well as other scattered hairs.[17,21] Although it is most likely to be the least expensive and first method chosen by patients, its tediousness makes it impractical for use over large areas.[5,16]

Table 1 The advancement of hair removal methods through time

Hair removal method	Advancement (what was used and where)
Shaving	Prehistoric cave drawings show men without beards or facial hair indicating they most likely used a flint ax or sharpened animal teeth to remove hair [13]
	Native Americans and Pacific islanders used sharpened sea shells to scrape off hair [8]
	Sharpened obsidian (a volcanic glass) was used by Ancient Mayans and Aztecs of Latin America to remove unwanted hair [8]
	Ancient Egyptians shaved their body hair with pumice and flint razors [10,13]
	King Camp Gillette created the first safety razor with disposable blades in 1885 [13]
	The first electric shaver was made by Col. Jacon Schick in 1931.
Chemical depilatories	Ancient Turks made Rhusma. a mixture of arsenic trisulphide. quicklime, and starch to dissolve hair at the skin's surface [8]
	Native Americans used caustic lye to bum hair [8]
	In the 1940s, the most popular chemical depilatory to date was invented
Plucking/Twee zing	Facial hair was removed prehistorically by pushing two shells together to tweeze hairs [8]
	Native Brazilian tribes used pieces of split bamboo as tweezers to pluck their lashes and eyebrows[8]
Waxing/Sugaring	Sugaring was made in the Middle East by cooking sugar, lemon, and other pastes to form a paste that was put directly on the skin [8]
	Women in Ancient Egypt used beeswax to remove leg hair [8]
	The waxy sap of the coco de mono tree was used for waxing in early Brazil and Venezuela [8]
Threading	In ancient China and Arabia, pieces of string were used to tie and pull out unwanted hair [8]
Electrolysis	In 1875. Charles E. Michel, an ophthalmologist, invented electrolysis, which was originally intended to remove ingrown eyelashes (he used galvanic current and a surgical needle to destroy the hair follicle) [8]
	According to the FDA it is currently the only method for permanent hair removal
Laser hair removal	The use of lasers to damage hair follicles was noted in the 1960s when reports were released on the usage of the ruby-laser on skin by Dr. Leon Goldman[14]
	However, these lasers were not able to specifically target the hair follicles and were not approved by the FDA
	The first laser for specific hair removal cleared by the FDA was the Nd:YAG by ThermoLase in 1995 [15]
	In 1997, the FDA approved hair lasers that target melanin in the hair
	The first at home laser hair removal device was approved in 2008 by the FDA

Plucking typically does not change the rate of hair growth and is therefore known as a temporary form of hair removal. Research has proven this to be true except when the hair is plucked during the anagen phase, which may lead to a delay in the reappearance of the anagen hair and a longer telogen phase.[5,7] Moreover, repetitive plucking of a hair may result in permanent damage of the matrix and failure of the hair to regrow.[5,7,21] With comparison to depilation, plucking provides a longer regrowth period, as the entire hair is being removed, but the exact time frame is dependent on the given body area. This method, although convenient, depends on the individual's tolerance and technique, as discomfort, scarring, and hyperpigmentation are common.[17–19]

Waxing/sugaring

Waxing and sugaring are ancient forms of hair removal that remove multiple hairs at one time from their roots. Although the techniques are very similar, the ingredients in their respective substances are quite different. Sugaring, known as *sukkar* in the Middle East and Egypt, and *moum* in Iran, is an ancient form of hair removal consisting of a paste made from sugar and lemon juice.[17,22] The wax, which can be hot or cold, used in waxing, is commonly mixed with resins (aiding in the pulling out of hair by hardening around the hair shaft) with or without mineral oils and perfumes.[5,7] The substances in both cases are spread evenly in the direction of hair growth and are allowed to dry and harden around the hair (waxing) or stick to the hair (sugaring), entrapping the hairs to be removed.[16,18,22] A cloth strip is used with sugaring and in some cases with waxing to facilitate an abrupt pull of the substances in the direction opposite of the hair growth taking the hairs with it.[5,8,17,22]

These temporary methods are efficient in treating large areas of unwanted hair with results usually lasting 2–8 weeks depending on hair growth.[8,18] However, for hair to be successfully removed a certain length needs to be achieved prior to treatment, skin irritation and allergic reactions may occur, as well as burns when using hot wax.[7,16,18] In general, waxing is preferred for smaller more specific areas, such as the eyebrows, while sugaring is preferred for larger body surface areas, such as the legs.[22] Use of these methods may be painful, but have proven to be quick and easy methods for removal of large areas of hair.

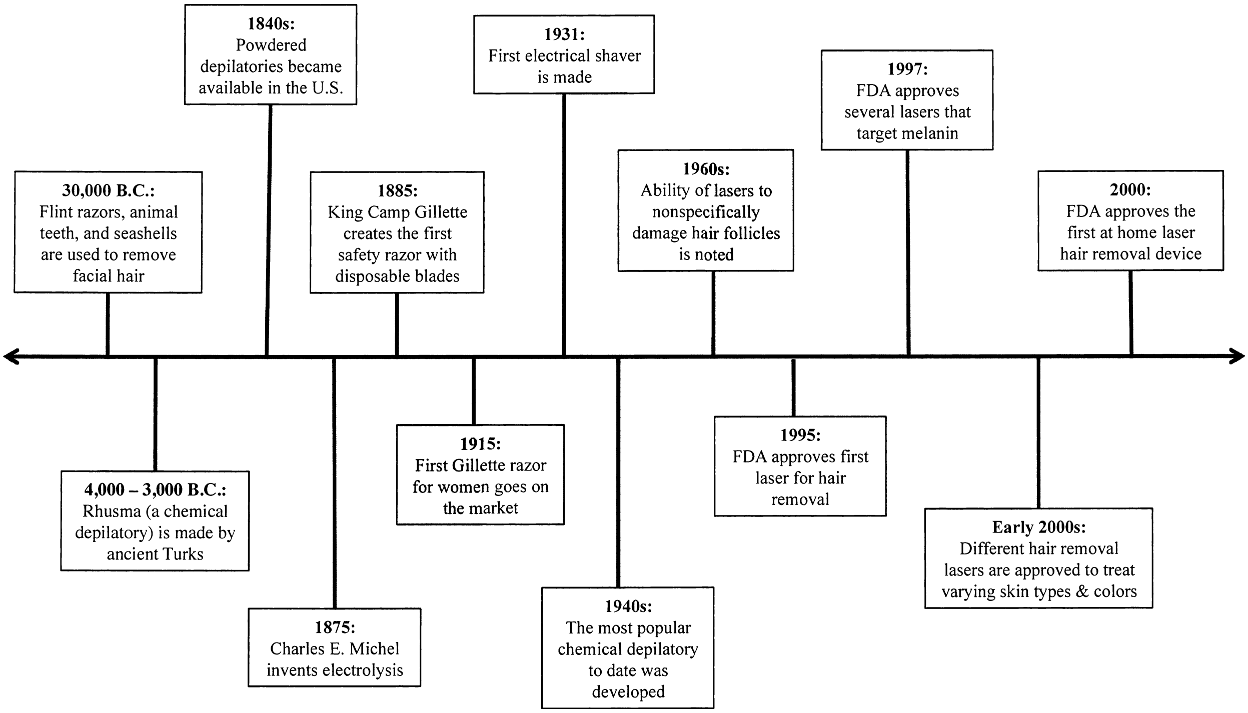
30,000 B.C.:
Flint razors, animal teeth, and seashells are used to remove facial hair
4,000 – 3,000 B.C.:
Rhusma (a chemical depilatory) is made by ancient Turks
1840s:
Powdered depilatories became available in the U.S.
1875:
Charles E. Michel invents electrolysis
1885:
King Camp Gillette creates the first safety razor with disposable blades
1915:
First Gillette razor for women goes on the market
1931:
First electrical shaver is made
1940s:
The most popular chemical depilatory to date was developed
1960s:
Ability of lasers to nonspecifically damage hair follicles is noted
1995:
FDA approves first laser for hair removal
1997:
FDA approves several lasers that target melanin
Early 2000s:
Different hair removal lasers are approved to treat varying skin types & colors
2000:
FDA approves the first at home laser hair removal device

Figure 1 Timeline - Important events that contributed to the development of hair removal methods. (note: timeline not to scale).

Threading

Threading is a skillful technique that acts much like plucking in temporarily removing individual hairs from small areas. A twisted cotton thread is used where one end is held in the specialist's hand and the other by the teeth, the open loop is then pressed against the area to be treated decreasing in size until the hair is trapped and pulled out of the skin.[16] The tediousness and precision of this method leads to the removal of some hairs at their roots while others are just cut off by the scissoring action of the thread.[17] This method is widely practiced in the Middle East where men commonly use it for the removal of hair from their cheeks, ears, and foreheads, whereas women use it for the removal of facial hair.[16,20] Although painful, threading is gaining popularity in Western cultures for its ability to skillfully shape hair specifically eyebrows.

Electrolysis

Electrosurgical epilation is currently the only form of *permanent* hair removal as stated by the FDA. Three types of electrolysis are performed: galvanic electrolysis, thermolysis, and a combination/blend method. All three of these methods involve the insertion of a small needle or probe into the hair follicle through which an electric current is passed in attempt to destroy the follicle itself so the hair cannot grow back.[8,23]

The oldest form of this method, galvanic electrolysis, works by damaging the hair follicle through a caustic chemical reaction. This procedure requires the passing of low flow direct current through the electrolysis needle to produce sodium hydroxide from the water and sodium chloride within the hair follicle destroying the follicular tissue.[18] Hair is removed individually making this technique a slow, expensive, and painful process. The maximum current passed through the needle depends on the amount of pain the individual can tolerate, with each hair taking from 15 seconds to 3 minutes to remove.[7] Multiple treatments are often necessary, however, strong indications show that the use of galvanic electrolysis reduces the number of active hair follicles by 80–90%.[24]

Thermolysis functions by damaging the hair follicle thermally rather than chemically. With this technique, high frequency alternating current is passed down the electrolysis needle instead of direct current producing heat in the follicle by molecular vibration, consequently destroying it.[16–18] As with galvanic electrolysis, individual hairs are targeted as well, but the process is much faster. Only 0.02–20 seconds are needed for each hair with as many as 100 hairs being able to be removed within a 20-minute period.[5,25] This type of electrolysis, although less painful, is less effective due to the brief current duration, which is set by the machine and not the operator.[7,18] Following each session of thermolysis, hair has been found to regrow in 20–40% of the follicles treated.[17]

The combination/blend technique is just that, a combination of both galvanic electrolysis and thermolysis. With this method a single machine subjects the hair follicle to both chemical and thermal destruction by delivering direct and alternating currents through the needle.[16,17] This is considered by most users to be the most effective form of electrolysis, as it is performed as rapidly as thermolysis and is thought to be less painful than galvanic electrolysis.[18]

Although some of the techniques of electrolysis are quicker than others, electrolysis overall is a slow and tedious method that (more commonly than not) requires multiple treatments. Therefore, electrolysis is most appropriate for the removal of unwanted hair from localized sparse areas, such as facial hair.[21] The skill of the operator is extremely important, as they have been found to be solely responsible (in addition to the differences in equipment) for the efficacy of the electrolysis. Not only has the wide range of regrowth rates been attributed to their skills, but the formation of scars, keloids, and post inflammatory pigment changes as well.[5,17] Overall, all three forms of electrolysis have proven to be effective in damaging a high percentage of the hair follicles treated given the proper technique.

Laser hair removal

Much progress has been made since the discovery of lasers to nonspecifically damage hair follicles nearly 60 years ago. Lasers, which stands for “light amplification stimulated emission of radiation”, used for hair removal are based on the ability to remove hair without damaging the surrounding skin, a theory known as selective photothermolysis.[8,26] Selective photothermolysis states that at a particular wavelength, pulse duration, and fluence, thermal injury will be confined to the target containing a light-absorbing molecule known as a chromophore.[26,27] Moreover, this means that a given target can absorb light of a specific wavelength in an amount of time that is equal to or less than its thermal relaxation time.[26]

The light emitted by the laser is absorbed by either melanin, a natural chromophore found in hair follicles, or by implementing another technique in which an exogenous substance/chromophore is topically applied and absorbed down the hair follicle. The energy of the laser is then transformed into heat causing selective destruction of the follicle; however, skin damage or absorption interference can occur if too much melanin is found in the surrounding skin.[5] Thus, the ideal candidate for hair removal with lasers should have untanned pale skin (phototypes I-II) with dark hair.[17] Lasers with longer wavelengths have since been developed and are now available to treat darker skin types with minimal damage to surrounding skin. Longer wavelengths are needed to treat darken skin types, since generally, as the wavelength increases, so does the depth of the penetration, with most penetrating wavelengths being from 600 to 1200 nm.[18] The different types of lasers/light sources that are readily used to target a variety of hair colors and skin types, such as the Ruby laser, Alexandrite laser, Diode laser, Nd:YAG laser, and Intense pulse light source are described (Table 2).

Ruby laser

The long pulse ruby laser was the first laser developed and was first reported for dermatologic use by Dr. Leon Goldman in the 1960s. As with the alexandrite and diode lasers, the ruby laser specifically targets melanin in the hair follicle. With a 694-nm wavelength, the ruby laser has the best absorption by melanin, but also the shortest penetration depth.[32] The short wavelength of this laser increases the risk for epidermal injury due to greater chance of absorption of the emitted light by the melanin found in the surrounding skin.[33] To reduce the risk of injury, a cooling hand piece is used in tandem during treatment to the lower the temperature of the skin.[32] This keeps the hair follicle at a temperature hot enough to cause destruction, while keeping the epidermis at a temperature below damage threshold.[34] In one study, it was reported that this laser had better results when using higher fluences; however, using higher fluences increases the risk of side effects, including pigmentary alteration and scarring especially in darker skin types (phototypes IV-VI).[33,35–37] Therefore, this laser is best indicated for use by individuals with light skin (phototypes I-III) and dark hair.[28]

To better treat patients, ruby lasers with longer pulse durations have been developed. There are three different ruby lasers currently used for hair removal all differing in power, pulse duration, fluence, and/or spot size.[7] The efficacy of the ruby laser has been demonstrated with 20–60% hair reduction after a single treatment and 50–78% reduction after multiple treatments.[27,29] In comparing the same number of treatments of waxing or electrolysis with that of the ruby

Table 2 Lasers and light sources for hair removal

Laser/Light source	Wavelength	Skin types	Target	Type of hair removal
Ruby	694 nm	Light skin	Melanin	Temporary
Alexandrite	755 nm	Light and dark skin	Melanin	Temporary
Diode	800 nm	Light and dark skin	Melanin	Temporary
Q switched Nd:YAG	1064 nm	Dark skin	Melanin	Temporary
Q switched Nd:YAG + Carbon particles	1064 nm	Dark skin	Carbon chromophore	Temporary
Intense pulse light source	550–1200 nm	Light skin and dark skin	Melanin as well as exogenous chromophores	Temporary

laser, it was found that the laser produced a 38–49% hair reduction, whereas the other two methods provided no significant change.[37,38] In all, under the right conditions, the ruby laser has proven to be very effective for long-term hair reduction.

Alexandrite laser

Long pulsed alexandrite lasers targeting melanin have also been introduced for hair removal. This laser has a wavelength of 755 nm. Its mechanism of action is similar to that of the ruby laser; however, the longer wavelength allows for a greater depth of penetration and a lower risk of epidermal damage due to slightly less melanin being absorbed at this wavelength.[34] The greater depth of penetration allows this laser to be used in individuals with darker skin (phototypes IV-VI), although it is commonly used for individuals with skin phototypes I-IV.[27,30] Studies have shown in some patients with darker skin that blistering, hyperpigmentation, and hypopigmentation may still occur.[33,36] As with the ruby laser, the alexandrite laser also uses cooling mechanisms. These include a cooling hand piece with a continuous flow of cool air and a dynamic cooling device that releases short spurts of cryogen to the skin that are used concomitantly during treatment.[32]

Efficacy of the alexandrite laser has been found to be highly variable mostly due to treatment location, spot size, and pulse duration. One trial using a long pulsed alexandrite laser with a total of four sessions at 8-week intervals showed a 76–84% hair reduction 18 months after the last treatment.[31] In two different studies performed (one reported a 78% clearance of hair 1 year following five treatments, the other reported a 74% hair reduction after three treatments) as well as a follow-up study, they all concluded that their success was due partly to a larger spot size at a given fluence, which delivered greater energy per pulse with deeper penetration and less scatter.[32,39–41] The alexandrite laser was also found to not only be more effective (a 74% hair reduction *vs.* a 35% reduction), but also less painful in a study conducted in which three laser treatments were compared with four treatments of electrolysis.[42]

Diode laser

The long pulsed diode is another FDA approved laser used for LHR using melanin as a chromophore. This laser has an 800 nm wavelength and patients can be treated at variable fluences and pulse widths. Studies suggest that the longer wavelength and adjustable pulse duration allows for effective removal of dark terminal hair as well as the treatment of darker skin types.[28] The diode laser has found to be able to be safely used in patients with skin phototypes I-V.[1] This laser uses a sapphire hand piece for cooling that is placed directly in contact with the skin allowing for higher doses of energy.[43]

Many studies have reported different results regarding the efficacy of the diode laser due to the area treated, pulse duration and number of treatments. After one session, one study found a 32% decrease in hair growth at treatment sites compared with a 45% decrease after two treatments 1 month apart.[7] Another study comparing the alexandrite and diode laser found a 85% and 84% long term hair reduction, respectively, 1-year post treatment.[44] Toosi, Sadighha *et al.* found no statistical difference 6 months post treatment when comparing the alexandrite laser, IPL, and diode laser, but found that the efficacy of the diode laser was significantly related to the number of treatment sessions.[45] These studies suggest that the diode laser is most effective when multiple treatments are performed and in treating patients with darker skin types.

Nd:YAG laser

The Nd:YAG laser may be continuous wave, pulsed, or Q- switched. The Q- switched Nd:YAG lasers have a very short pulse and operate at a high powered

1064 nm promoting hair removal by extremely rapid heating of the melanin in the hair follicle.[16] It was found that at this high wavelength, absorption of laser light by melanin was very low in hair bulb/bulge and thus ineffective for long-term hair removal. The rapid heating causes focal photomechanical disruption of the melanocytes in the hair bulb, but doesnot complete follicular destruction.[46–48] Therefore, in conjunction with the laser, an exogenous carbon chromophore is commonly topically applied and allowed to penetrate the hair follicle prior to treatment for better absorption.[18] Different cooling options are available depending on the laser used, including a chill tip, pulsed cryogen delivery, precooling, and air cooling.[32]

The long pulsed Nd:YAG laser has been found to be the most safe and effective laser in treating tanned or darker skinned patients, specifically those with skin photoype VI.[1] A study found that after 6 months, patients with skin types I-II had a 41–43% hair reduction, whereas those with skin types III-IV had a 44–48% hair reduction.[49] Although it may be the safest method of hair removal compared with other forms of LHR, this technique seems to be the least effective. In another study, Bouzari *et al.*[50] found that after 3 months comparing the Nd:YAG, alexandrite, and diode laser, the Nd:YAG laser was the least effective. In general, studies show that this laser successfully delays hair growth, but fails to produce long lasting hair removal.[28]

Intense pulsed light source

Intense pulsed light (IPL) is a nonlaser light source used for hair removal. IPL sources can emit light at wavelengths ranging from 550 to 1200 nm using filters to generate these wavelengths.[27] The cutoff filters are primarily used to exclude shorter wavelengths hence, only more deeply penetrating wavelengths are emitted, which can target particular chromophores, including melanin.[1] These filters allow the operator to tailor the spectrum of light specific to the skin type and hair color of the patient, allowing for a wide range of skin types to be treated.[7,28] IPL sources contain a chilled hand piece and transparent gel with additional cooling to keep the surrounding skin cooled.[51] Unlike lasers, which produce monochromatic light, IPL use flash lamps to produce noncoherent light.[52] The polychromatic light used by IPL systems can be used at the same time to treat pigmented and vascular lesions.[32]

As with laser, multiple treatments increase the chances for long-term hair removal. However, one study showed that after one treatment 60% hair reduction was seen 12 weeks post treatment with better results seen in those with darker hair.[18] Another study following the long-term effects of this laser on hirsute women found an 87% hair reduction after eight treatments over an average of 27.4 months.[53] One trial comparing one treatment of IPL with one treatment using the Nd:YAG laser in patients with skin types IV-VI found no significance in hair reduction, but found that the IPL treatment resulted in postinflammatory pigmentation, whereas the laser did not.[37,54] Moreover, in another study comparing three treatments of IPL with three treatments using the ruby laser on skin types II-IV, 94% of patients obtained an average of 49% hair reduction with IPL, whereas only 55% of patients had an average of 21% hair reduction with the laser.[37,55] This supports that IPL is comparable to lasers with longer wavelengths with regards to hair removal and better at treating darker skin types when compared with lasers with shorter wavelengths.

Although once thought to be a permanent form of hair removal, LHR does cause a reduction in hair growth with one treatment, but requires multiple treatments for a decrease in hair growth, that is cosmetically acceptable.[22] After one treatment, a delay of 2–6 months can be observed with hair regrowth being sparser with thinner individual hairs.[17] For optimal results, shaving prior to treatment is recommended to prevent conduction of thermal energy to the adjacent epidermis from surrounding hairs.[17] Refraining from tanning throughout the duration of LHR treatments is also suggested. Overall, LHR is most effective when treating individuals with dark hair and light skin and is least effective in treating white, blonde or grey hair. For treatment of darker skin types (IV-V), the alexandrite lasers, diode lasers, and IPL source operating at longer wavelengths and pulse duration should be used in combination with a cooling device for the most safe treatment possible.[16] In general, LHR is known to be painful with edema and erythema being common side effects; hypopigmentation or hyperpigmentation may also occur depending on skin color, especially for individuals of darker skin types.[5]

Future of hair removal

As shown, much advancement in hair removal has been made since the use of sea shells and animal teeth to pry facial hair. These developments have not only made hair removal easier to perform, but due to the vast disposability, more economically affordable as well. However, more advancement is needed to further broaden the success of permanent hair removal.

With the growing popularity of hair removal procedures, several optical home-based hair removal devices have been developed to satisfy an overwhelming demand from consumers for the convenience of home hair-removal treatment. Currently, there are 12 home-based laser or intense pulsed light (IPL) hair removal devices available to the public for purchase: 10 are IPL-based systems (400–1200 nm wavelengths) and two are diode lasers (800 nm and 808 nm wavelengths).[56] Thaysen-Peterson *et al.*[56] performed a comprehensive literature search and identified seven prospective clinical trials (1CT, RUCT, 0RCT) that specifically addressed the efficacy and adverse effects of home hair removal devices. Home-based hair removal treatments seem to induce significant short-term hair removal when evaluated up to 6 months after treatment; still, long-term efficacy is not yet available. The incidence of adverse effects amongst these seven studies was not quantitatively different than that reported in professional hair-removal studies; however, the incidence of adverse effects remains unknown.[56] Intuitively, when procedures move from the hands of a professional to those of a lay individual, issues of efficacy, and more importantly, safety, are raised.

Future directions of hair removal needs to focus on more effective targeting of white and blonde hairs, as current lasers are not able to effectively target these hairs due to low or absent melanin in the hair bulbs. According to Ibrahimi *et al.*,[1] the future of hair removal lies in pain control, use of home-based hair removal devices, and the development of alternative technologies for hair removal.

Conclusions

In conclusion, it appears that the removal of hair has been around since the beginning of history. There have been dramatic developments from the use of ordinary objects to advanced lasers with advancements still being sought (Fig 1).

This article provides the reader with the basic structure and function of hair, including the hair growth cycle, which is essential in understanding the reasons for the effectiveness of hair removal treatments. In addition, we provide the reader with the history of hair removal throughout time from what was used in the beginning of history to what is currently used as well as a brief overview of the different methods of hair removal. The reasons for hair removal are also provided, highlighting that social norms are still the leading motive for seeking hair removal. With this timeline, we hope to provide dermatologists and other physicians with a broad foundation of the development of hair removal methods and the reasons why patients may seek treatment. In our advanced scientific world of today, we hope the future of hair removal will focus on more efficacious treatment of white and blonde hair, pain control, home-based hair removal devices, and the development of a cost-effective permanent hair removal method.

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